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TI Manufacture of copper alloy thin **wire** having high strength and fatigue resistance
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PA Furukawa Electric Co., Ltd., Japan
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AB Cu alloy thin **wire** having diam. .ltoreq.50 .mu.m is from Cu-(1.0-4.5%)Ag alloy, Cu-(0.2-1.5%)Cr alloy, Cu-(0.1-0.3%)Zr alloy, Cu-(0.2-1.5)Cr-(0.1-0.3%)Zr alloy or Cu-(0.3-4.0%)Ti alloy by cold drawing at .ltoreq.99.999% draft optionally with intermediate annealing. When intermediate annealing is carried out, the cold draft between intermediate annealing processes is .ltoreq.99.999% and the cold draft after the final annealing is 80-99%.

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(54)【発明の名称】　銅合金極細線の製造方法

(57)【要約】
【課題】　伸線性、強度、耐疲労特性などに優れる線径が５０μｍ以下の銅合金極細線の製造方法を提供する。
【解決手段】　晶出物などの異相を含む銅合金軟質素材（Ｃｕ－１．０～４．５wt％Ａｇ合金、Ｃｕ－０．２～１．５wt％Ｃｒ合金、Ｃｕ－０．１～０．３wt％Ｚｒ合金、Ｃｕ－０．２～１．５wt％Ｃｒ－０．１～０．３wt％Ｚｒ合金、またはＣｕ－０．３～４．０wt％Ｔｉ合金など）を冷間加工し、必要に応じて中間焼鈍を施す、線径５０μｍ以下の銅合金極細線の製造方法であって、前記銅合金軟質素材からの冷間加工率を９９．９９９％以下にし、最終中間焼鈍以外の中間焼鈍後の次の中間焼鈍までの冷間加工率を９９．９９９％以下にし、最終中間焼鈍後の冷間加工率を８０～９９％にする。

【特許請求の範囲】

【請求項１】　晶出物などの異相を含む銅合金軟質素材を冷間加工し、必要に応じて中間焼鈍を施す、線径５０μm以下の銅合金極細線の製造方法であって、前記銅合金軟質素材からの冷間加工率を９９．９９９％以下とし、中間焼鈍を施す場合は、中間焼鈍と中間焼鈍の間の冷間加工率は９９．９９９％以下とし、最終中間焼鈍後の冷間加工率は８０～９９％にすることを特徴とする銅合金極細線の製造方法。

【請求項２】　晶出物などの異相を含む銅合金軟質素材がCu－１．０～４．５wt％Ag合金、Cu－０．２～１．５wt％Cr合金、Cu－０．１～０．３wt％Zr合金、Cu－０．２～１．５wt％Cr－０．１～０．３wt％Zr合金、またはCu－０．３～４．０wt％Ti合金であることを特徴とする請求項１記載の銅合金極細線の製造方法。

【請求項３】　中間焼鈍を３００～５５０℃で１秒～３０分間保持して施すことを特徴とする請求項１または２記載の銅合金極細線の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、伸線性、強度、耐疲労特性などに優れ、特に巻線に適した線径５０μm以下の銅合金極細線の製造方法に関する。

【０００２】

【従来の技術】巻線などに使用される銅合金極細線には、伸線性、強度、耐疲労特性などが要求される。特に、伸線性はコストに大きく影響するので重要である。このような銅合金極細線には、従来より、タフピッチ銅、Sn入り銅合金、０．２％以下のAgを含む銅合金などが用いられてきた。そして、近年の携帯機器の小型化に伴って、巻線用極細線には５０μm以下、さらには３０μmから２０μmへと細線化が求められ、また強度や耐疲労特性なども以前より重視されるようになってきている。

【０００３】

【発明が解決しようとする課題】しかし、従来の銅合金極細線は５０μm以下の径になると断線し易くなり生産性に問題が生じている。そこで、本発明者等は、冷間加工性に優れる銅合金を種々探索し、Agを１％以上含有する銅合金やCu－Cr合金などは加工条件を選定することにより２０μm以下の径に細線化できることを見いだし、さらに研究を進めて本発明を完成させるに至った。本発明の目的は、伸線性、強度、耐疲労特性などに優れる線径が５０μm以下の銅合金極細線の製造方法を提供することにある。

【０００４】

【課題を解決するための手段】請求項１記載の発明は、晶出物などの異相を含む銅合金軟質素材を冷間加工し、必要に応じて中間焼鈍を施す、線径５０μm以下の銅合金極細線の製造方法であって、前記銅合金軟質素材からの冷間加工率を９９．９９９％以下とし、中間焼鈍を施す場合は、中間焼鈍と中間焼鈍の間の冷間加工率は９９．９９９％以下とし、最終中間焼鈍後の冷間加工率は８０～９９％にすることを特徴とする銅合金極細線の製造方法である。

【０００５】請求項２記載の発明は、晶出物などの異相を含む銅合金軟質素材がCu－１．０～４．５wt％Ag合金、Cu－０．２～１．５wt％Cr合金、Cu－０．１～０．３wt％Zr合金、Cu－０．２～１．５wt％Cr－０．１～０．３wt％Zr合金、またはCu－０．３～４．０wt％Ti合金であることを特徴とする請求項１記載の銅合金極細線の製造方法である。

【０００６】請求項３記載の発明は、中間焼鈍を３００～５５０℃で１秒～３０分間保持して施すことを特徴とする請求項１または２記載の銅合金極細線の製造方法である。

【０００７】

【発明の実施の形態】本発明は、晶出物などの異相を含む銅合金軟質素材を、必要に応じて中間焼鈍を施しつつ、所定の加工率で冷間加工して、線径５０μm以下の極細線に加工する方法である。前記晶出物などの異相には析出物なども含まれる。銅合金軟質素材としては、Cu－１．０～４．５wt％Ag合金、Cu－０．２～１．５wt％Cr合金、Cu－０．１～０．３wt％Zr合金、Cu－０．２～１．５wt％Cr－０．１～０．３wt％Zr合金、またはCu－０．３～４．０wt％Ti合金などの小径鋳塊、熱間圧延材（荒引線）、熱間押出材、焼鈍材などが挙げられる。前記銅合金軟質素材は、圧延、溝ロール圧延、引抜加工、伸線加工などにより冷間で加工されて所望形状の極細線に加工される。

【０００８】前記各銅合金には、合金元素の晶出物などの異相（Ag粒子、Cr粒子、Zr・Cu化合物粒子、Ti・Cu化合物粒子など）がそれぞれ冷間加工により短繊維状に微細に分散しており、これら分散物は、冷間加工に伴って銅合金マトリックスに形成される転位セルを微細かつ均一に分布させる作用を果たし、前記各銅合金の冷間加工性を向上させる。前記各銅合金の合金元素量の規定理由は、いずれも、下限未満では前記晶出物などが少ないため転位セルが微細かつ均一に分布せず、上限を超えると晶出物などが著しく粗大化して断線を惹起するためである。

【０００９】前記晶出物は、前述のように、転位セルを微細かつ均一化するが、反面、冷間加工が進むと転位セルが著しく微細化し、そこに転位がピン止めされて断線が起き易くなる。

【００１０】そこで、本発明では、前記銅合金軟質素材からの冷間加工率が９９．９９９％を超える場合は、中間焼鈍を施して断線を防止する。中間焼鈍により、転位が熱活性的に移動して転位セルが粗大化して冷間加工性

が改善される。中間焼鈍を複数回施す場合の中間焼鈍間の冷間加工率は、前記銅合金軟質素材からの冷間加工率と同じように９９．９９９％以下にする。但し、最終中間焼鈍後の冷間加工率は８０～９９％に規定する。その理由は、８０％未満では銅合金極細線に必要な強度が得られず、９９％を超えると転位セルが微細化してコイリングなどの際に断線し易くなるためである。なお、Ｃｕ－Ｃｒ合金、Ｃｕ－Ｚｒ合金、Ｃｕ－Ｔｉ合金は、冷間加工後、時効処理を施すことによりさらに強度を向上させることができる。

【００１１】前述のように、転位セルが微細に形成された冷間加工線材を中間焼鈍すると、転位が熱活性的に移動して転位セルが粗大化して冷間加工性が改善される。前記中間焼鈍は、焼鈍温度が３００℃未満ではその効果が十分に得られず、５５０℃を超えると焼鈍による強度低下が大きく、以後、冷間加工しても十分な強度が得られなくなる。また焼鈍時間が１秒未満では転位が熱活性的に移動するための時間が不足し、また３０分を超えると中間焼鈍の効果が飽和してエネルギーコスト的に不利になる。従って中間焼鈍は３００～５５０℃で１秒～３０分間施すのが望ましい。

【００１２】

【実施例】以下に本発明を実施例により詳細に説明する。

（実施例１）本発明規定内組成の種々の銅合金を横型連続鋳造機により１０．８mm径の棒状鋳塊に鋳造し、この鋳塊を１０mm径に皮むきし、この皮むき後の鋳塊を伸線加工して０．１０mm径または０．０５mm径の線材とした。次いで前記各線材に３００～５５０℃で３０秒間保持する条件で走間焼鈍を施し、その後再び伸線加工して２０μｍ（０．０２mm）径の銅合金極細線を製造した。

【００１３】（実施例２）本発明規定内組成の種々の銅合金を横型連続鋳造機により１０．８mm径の棒状鋳塊に鋳造し、この鋳塊を１０mm径に皮むきし、この皮むき後の鋳塊を伸線加工して０．１０mm径または０．０５mm径の線材とした。次いで前記各線材に５８０℃または２８０℃で３０秒間保持する条件で走間焼鈍を施し、その後再び伸線加工して２０μｍ径の銅合金極細線を製造した。

【００１４】（比較例１）本発明規定内組成の種々の銅合金を横型連続鋳造機により１０．８mm径の棒状鋳塊に鋳造し、この鋳塊を１０mm径に皮むきし、この皮むき後の鋳塊を伸線加工して０．３０mm径または０．０３mm径の線材とした。次いで前記各線材に４００℃で３０秒間保持する条件で走間焼鈍を施し、その後再び伸線加工して２０μｍ径の銅合金極細線を製造した。

【００１５】（比較例２）本発明規定内組成の種々の銅合金を横型連続鋳造機により１０．８mm径の棒状鋳塊に鋳造し、この鋳塊を１０mm径に皮むきし、この皮むき後の鋳塊を伸線加工して２０μｍ径の銅合金極細線を製造した。途中走間焼鈍は施さなかった。

【００１６】（比較例３）本発明規定外組成の銅合金を横型連続鋳造機により１０．８mm径の棒状鋳塊に鋳造し、この鋳塊を１０mm径に皮むきし、この皮むき後の鋳塊を伸線加工して０．１０mm径または０．０５mm径の線材とした。次いで前記各線材に４００℃で３０秒保持する条件で走間焼鈍を施し、その後再び伸線加工して２０μｍ径の銅合金極細線を製造した。

【００１７】実施例１、２、比較例１～３で得られた各々の銅合金極細線について、引張強さ、疲労破断特性、伸線性を調査した。疲労破断特性は２００Ｎ／mm^2 の応力を負荷しつつ９０度曲げを繰返したときの破断までの回数で表した。１往復を１回と数えた。伸線性は３０μｍから２０μｍに連続伸線したときの破断回数で伸線量を除した値で表した。合金組成の分析値を表１に、調査結果を表２～５にそれぞれ示す。表２～５には伸線条件および焼鈍条件を併記した。

【００１８】

【表１】

	合金	Ａｇ	Ｃｒ	Ｚｒ	Ｔｉ		合金	Ａｇ	Ｃｒ	Ｚｒ	Ｔｉ
本発明規定内組成合金	1	1.0	−−	−−	−−	本発明規定外組成合金	１０	0.2	−−	−−	−−
	2	2.0	−−	−−	−−		１１	−−	0.15	−−	−−
	3	4.0	−−	−−	−−		１２	−−	−−	0.05	−−
	4	−−	0.3	−−	−−		１３	−−	0.04	0.03	−−
	5	−−	1.3	−−	−−		１４	−−	−−	−−	0.1
	6	−−	−−	0.25	−						
	7	−−	0.28	0.22	−−						
	8	−−	−−	−−	0.5						
	9	−−	−−	−−	3.8						

(注) 単位wt％。

【００１９】

【表２】

分類	試料	合金	焼鈍サイズ # mm	焼鈍温度 ℃	引張強さ Ｎ／㎟	疲労破断回数×10⁶	伸線性 kg／１断線
本発明例	1	1	０．１	４００	８４０	１７	３．９
	2		０．０５	４００	８００	１０	４．１
	3	2	０．１	５５０	８８０	２３	３．５
	4		０．１	４００	９５０	４０	３．８
	5		０．１	３００	９７０	４２	３．６
	6		０．０５	４００	９００	３５	４．２
	7	3	０．１	４００	１０１０	４５	３．６
	8		０．０５	４００	９６０	４１	３．４
	9	4	０．１	４００	８９０	２４	３．５
	10		０．０５	４００	８５０	１８	４．０
	11	5	０．１	４００	９６０	４１	３．５
	12		０．０５	４００	９２０	３７	３．７

(注) ＃10mm径−(99.99%)−→ 0.1mm径−(96%) →0.02mm径
10mm径−(99.9975%)→0.05mm径−(84%) →0.02mm径
試料No.1〜12は実施例１。

【００２０】

【表３】

分類	試料	合金	焼鈍線径 #　mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断 回数×10⁶	伸線性 kg／１断線
本発明例	13	6	０．１	４００	８５０	１５	３．８
	14		０．０５	４００	８００	１０	４．１
	15	7	０．１	４００	９４０	３５	３．５
	16		０．０５	４００	９００	２８	３．８
	17	8	０．１	４００	１１００	５０	３．１
	18		０．０５	４００	１０５０	４４	３．３
	19	9	０．１	４００	１２１０	５７	３．０
	20		０．０５	４００	１１４０	５３	３．１
	21	2	０．１	５７０	８４０	１４	３．７
	22		０．１	２８０	９９０	４３	３．４
	23	3	０．１	５７０	９１０	２９	３．６
	24		０．１	２８０	１０６０	４５	３．３

（注）＃10mm径－－(99.99%)→ 0.1mm径 (96%)→0.02mm径
10mm径－(99.9975%)→0.05mm径 (84%)→0.02mm径
試料No.13～20は実施例１、試料No.21～24は実施例２。

【００２１】

【表４】

分類	試料	合金	焼鈍線径 #　mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断 回数×10⁶	伸線性 kg／１断線
比較例１	25	2	０．３	４００	９８０	３３	１．３
	26		０．０３	４００	７２０	２．１	２．８
	27	3	０．３	４００	１０１０	３８	１．５
	28		０．０３	４００	７６０	３．３	２．６
	29	4	０．３	４００	９１０	１８	１．１
	30		０．０３	４００	６８０	１．１	２．２
	31	6	０．３	４００	８７０	１５	０．８
	32		０．０３	４００	６２０	０．９	１．４
	33	7	０．３	４００	９６０	２８	０．７
	34		０．０３	４００	７３０	１．８	１．６
	35	8	０．３	４００	１０７０	３９	１．９
	36		０．０３	４００	７９０	３．８	２．７

（注）＃10mm径－(99.91%)－→ 0.3mm径－(99.56%)→0.02mm径
10mm径－(99.9991%)→0.03mm径－(55.56%)→0.02mm径

【0022】

【表5】

分類	試料	合金	焼鈍サイズ # mm径	焼鈍温度 ℃	引張強さ N／mm²	疲労破断回数×10^6	伸線性 kg／1断線
比較例2	37	2	中間焼鈍なし		1050	34	0．34
	38	3	〃		1060	36	0．41
	39	4	〃		820	16	0．22
	40	6	〃		820	14	0．32
	41	7	〃		840	18	0．50
	42	8	〃		1010	33	0　37
比較例3	43	10	0．1	400	920	19	0．33
	44		0．05	400	870	14	0．52
	45	11	0．1	400	650	1．0	2．83
	46		0．05	400	620	0．8	2．52
	47	12	0．1	400	720	3．5	1．4
	48		0．05	400	620	1．1	1．6
	49	13	0．1	400	810	9．5	1．7
	50		0．05	400	780	3．3	1．2
	51	14	0．1	400	950	18	0．52
	52		0．05	400	920	21	0．44

（注）＃10mm径－(99.9996%)－－－－－－－－－→0.02mm径（中間焼鈍なし）
10mm径－－(99.99%)→ 0.1mm径 (96%)→0.02mm径
10mm径－(99.9975%)→0.05mm径 (84%)→0.02mm径

【0023】表2～5より明らかなように、本発明例の試料No.1～24は、いずれも、1断線あたり3．0kg以上の伸線性を有しているうえ、強度、耐疲労特性にも優れている（引張強さ800N/mm²以上、疲労破断回数が10^7回以上）。これに対し、比較例1の No.25～36と比較例2の No.37～42は冷間加工率が本発明の規定を外れたため、比較例3の No.43～52は合金元素量が少ないため、いずれも伸線性が低下して実用に適さないものであった。また最終中間焼鈍後の冷間加工率が99％を超えたもの（No.25,27,29,31,33,35）は、腰が弱くコイリング性（表示せず）に劣り、前記冷間加工率が80％未満のもの（No.26,28,30,32,34,36）は引張強さと疲労破断特性に劣った。合金元素量が不足したもののうちNo.45～50は引張強さと疲労破断特性の少なくとも1種が劣った。

【0024】

【発明の効果】以上に述べたように、本発明で用いる銅合金は、そこに含まれる晶出物などが転位セルを微細かつ均一に分布させるので冷間加工性に優れ、しかも本発明では前記銅合金を所定条件で、必要に応じて焼鈍を入れながら冷間加工するので、50μm以下の極細線を良好に製造することができる。さらに本発明にて得られる極細線は強度および耐疲労特性にも優れる。依って、本発明は、巻線などの製造に適用して顕著な効果を奏する。

フロントページの続き

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AN 1999:681605 HCAPLUS
DN 131:302273
TI Manufacture of copper alloy thin **wire** having high strength and fatigue resistance
IN Fujiwara, Hidemichi; Yamazaki, Akira; Osada, Katsuki
PA Furukawa Electric Co., Ltd., Japan
SO Jpn. Kokai Tokkyo Koho, 7 pp.
CODEN: JKXXAF
DT Patent
LA Japanese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 11293431	A2	19991026	JP 1998-99784	19980413

AB Cu alloy thin **wire** having diam. .ltoreq.50 .mu.m is from Cu-(1.0-4.5%)Ag alloy, Cu-(0.2-1.5%)Cr alloy, Cu-(0.1-0.3%)Zr alloy, Cu-(0.2-1.5)Cr-(0.1-0.3%)Zr alloy or Cu-(0.3-4.0%)Ti alloy by cold drawing at .ltoreq.99.999% draft optionally with intermediate annealing. When intermediate annealing is carried out, the cold draft between intermediate annealing processes is .ltoreq.99.999% and the cold draft after the final annealing is 80-99%.

PATENT ABSTRACTS OF JAPAN

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ıApplication number : 10-099784

ıDate of filing : 13.04.1998

(71)Applicant : FURUKAWA ELECTRIC CO LTD:THE

(72)Inventor : FUJIWARA HIDEMICHI
YAMAZAKI AKIRA
OSADA KATSUMI

· PRODUCTION OF COPPER ALLOY EXTRA FINE WIRE

ıAbstract:

ɔBLEM TO BE SOLVED: To provide a method for producing a copper alloy extra fine wire of ≤50 μm in ɩ diameter excellent in wire drawability, strength, fatigue resistance.

ˌUTION: This is a method for producing a copper alloy extra fine thin wire of ≤50 μm in wire diameter in ɔh a copper alloy soft stock contg. phases such as crystallized products (Cu-1.0 to 4.5 wt.% Ag alloy, 0.2 to 1.5 wt.% Cr allay, Cu-0.1 to 0.3 wt.% Zr allay, Cu 0.2 to 1.5 wt.% Cr-0.1 to 0.3 wt.% Zr alloy or 0.3 to 4.0 wt.% Ti alloy) is cold worked and is subjected to process annealing necessary, and in which cold working ratio from the copper alloy soft stock is regulated to ≤99.99%, the cold working ratio till the ›wing process annealing after the process annealing other than the final process annealing is regulated 99.999%, and the cold working ratio after the final process annealing is regulated to 80 to 99%.

ɪAL STATUS

te of request for examination]

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miner's decision of rejection or application
verted registration]

te of final disposal for application]

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[Date of extinction of right]

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the drawings, any words are not translated.

.IMS

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im(s)]
im 1] Cold-work the copper alloy elasticity material containing unusual appearances, such as a crystallization ct, and give intermediate annealing if needed. When it is the manufacture method of the copper alloy extra fine of 50 micrometers or less of wire sizes, the rate of cold working from the aforementioned copper alloy elasticity :rial is made into 99.999% or less and it gives intermediate annealing It is the manufacture method of the copper ' extra fine wire which makes the rate of cold working between intermediate annealing 99.9S9% or less, and is acterized by making the rate of cold working after the last intermediate annealing 80 - 99%.
im 2] The manufacture method of the copper alloy extra fine wire according to claim 1 characterized by the copper ' elasticity material containing unusual appearances, such as a crystallization object, being a Cu-1.0-4.5wt%Ag ', a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr alloy, a Cu-0.2-1.5wt%Cr-0.1-0.3wt%Zr alloy, or a Cu-0.3- rt%Ti alloy.
im 3] The manufacture method of the copper alloy extra fine wire according to claim 1 or 2 characterized by ing intermediate annealing for [1 second -] 30 minutes, and giving it at 300-550 degrees C.

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2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention is excellent in wire drawing nature, intensity, a defatigation-proof property, etc., and relates to the manufacture method of the copper alloy extra fine wire of 50 micrometers or less of wire sizes suitable for especially the coil.

[0002]

[Description of the Prior Art] Wire drawing nature, intensity, a defatigation-proof property, etc. are required of the copper alloy extra fine wire used for a coil etc. Since especially wire drawing nature influences cost greatly, it is important. The tough pitch copper, the copper alloy containing Sn, the copper alloy containing 0.2% or less of Ag, etc have been conventionally used for such a copper alloy extra fine wire. And with the miniaturization of a pocket devic in recent years, 20 micrometers is asked for thinning from 50 micrometers or less and 30 more micrometers at the extr fine wire for coils, and greater importance is increasingly attached to intensity, a defatigation-proof property, etc. than to before.

[0003]

[Problem(s) to be Solved by the Invention] However, if the conventional copper alloy extra fine wire became a diameter 50 micrometers or less, it will become easy to disconnect it, and the problem has produced it for productivity Then, by selecting processing conditions, this invention person etc. searched for various copper alloys which are excellent in cold-working nature, and it finds out that thinning can be carried out to a diameter 20 micrometers or less, and a copper alloy, a Cu-Cr alloy, etc. which contain Ag 1% or more advance research further, and came to complete this invention. The purpose of this invention is for the wire size which is excellent in wire drawing nature, intensity, a defatigation-proof property, etc. to offer the manufacture method of a copper alloy extra fine wire 50 micrometers or less.

[0004]

[Means for Solving the Problem] Invention according to claim 1 cold-works the copper alloy elasticity material containing unusual appearances, such as a crystallization object. When it is the manufacture method of the copper all extra fine wire of 50 micrometers or less of wire sizes which gives intermediate annealing if needed, the rate of cold working from the aforementioned copper alloy elasticity material is made into 99.999% or less and it gives intermediate annealing It is the manufacture method of the copper alloy extra fine wire which makes the rate of cold working between intermediate annealing 99.999% or less, and is characterized by making the rate of cold working aft the last intermediate annealing 80 - 99%.

[0005] Invention according to claim 2 is the manufacture method of the copper alloy extra fine wire according to clai 1 characterized by the copper alloy elasticity material containing unusual appearances, such as a crystallization object being a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr alloy, a Cu-0.2-1.5wt%Cr-0.1-0.3wt% Zr alloy, or a Cu-0.3-4.0wt%Ti alloy.

[0006] Invention according to claim 3 is the manufacture method of the copper alloy extra fine wire according to clai 1 or 2 characterized by holding intermediate annealing for [1 second -] 30 minutes, and giving it at 300-550 degrees C.

[0007]

[Embodiments of the Invention] this invention is the method of cold-working the copper alloy elasticity material containing unusual appearances, such as a crystallization object, by predetermined working ratio, giving intermediate annealing if needed, and processing it into the extra fine wire of 50 micrometers or less of wire sizes. A sludge etc. is contained in unusual appearances, such as the aforementioned crystallization object. As a copper alloy elasticity material, minor diameter ingots, such as a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr

', a Cu-0.2-1.5wt%Cr-0.1-0.3wt%Zr alloy, or a Cu-0.3-4.0wt%Ti alloy, hot rolling material (rough drawing wire), extrusion material, an annealed material, etc. are mentioned. The aforementioned copper alloy elasticity material is essed between the colds by rolling, grooved-roll rolling, drawing-out processing, wire drawing, etc., and is essed into the extra fine wire of a request configuration.
8] Cold working is distributing minutely in the shape of a staple fiber, respectively, and as for these distribution ct, in each aforementioned copper alloy, unusual appearances (Ag particle, Cr particle, a Zr-Cu compound particle, 'u compound particle, etc.), such as a crystallization object of an alloy element, achieve the operation which ibutes minutely and uniformly the transposition cell formed in a copper alloy matrix in connection with cold king, and raise the cold-working nature of each aforementioned copper alloy to it. Since there are few ementioned crystallization objects etc. under at a minimum, when no reasons for a convention of the amount of / elements of each aforementioned copper alloy are distributed minutely [a transposition cell] and uniformly but ed an upper limit, a crystallization object etc. is for turning and causing an open circuit big and rough remarkably.
9] the aforementioned crystallization object is detailed in a transposition cell as mentioned above -- and although it ilizes, on the other hand, if cold working progresses, a transposition cell will turn minutely remarkably, pinning of ransposition is carried out there, and an open circuit becomes easy to occur
.0] Then, in this invention, when the rate of cold working from the aforementioned copper alloy elasticity material eds 99.999%, intermediate annealing is given and an open circuit is prevented. By intermediate annealing, sposition moves in heat activity, a transposition cell turns big and rough, and cold-working nature is improved. The of cold working between intermediate annealing in the case of giving intermediate annealing two or more times is e 99.999% or less like the rate of cold working from the aforementioned copper alloy elasticity material. However, ate of cold working after the last intermediate annealing is specified to 80 - 99%. When the intensity which needs eason for a copper alloy extra fine wire at less than 80% is not obtained but it exceeds 99%, a transposition cell is urning and becoming easy to disconnect in the cases, such as coiling, minutely. In addition, a Cu-Cr alloy, a Cu-Zr y, and a Cu-Ti alloy can raise intensity further by giving an aging treatment after cold working.
.1] As mentioned above, if a transposition cell carries out intermediate annealing of the cold-working wire rod ied minutely, transposition will move in heat activity, a transposition cell will turn big and rough, and cold-working ire will be improved. When, as for the aforementioned intermediate annealing, the effect exceeds 550 degrees C by / not obtaining an annealing temperature at less than 300 degrees C, the on-the-strength fall by annealing is large, henceforth, even if it cold-works, sufficient intensity is no longer obtained. Moreover, if the time for annealing moving in [transposition] heat activity in less than 1 second runs short and it exceeds 30 minutes, the effect of rmediate annealing will be saturated and it will become disadvantageous in energy cost. Therefore, as for rmediate annealing, it is desirable to give for [1 second -] 30 minutes at 300-550 degrees C.
12]
ample] An example explains this invention in detail below.
ample 1) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this ention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of m, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of)mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod he conditions held for 30 seconds at 300-550 degrees C, wire drawing was again carried out to it after that, and the per alloy extra fine wire of the diameter of 20 micrometer (0.02mm) was manufactured.
13] (Example 2) The horizontal-type continuous casting machine cast the various copper alloys of the composition is invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of m, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of)mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod he conditions held for 30 seconds at 580 degrees C or 280 degrees C, wire drawing was again carried out to it after , and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
14] (Example 1 of comparison) The horizontal-type continuous casting machine cast the various copper alloys of composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled he diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod he diameter of 0.30mm, or the diameter of 0.03mm. Subsequently, annealing between ** was given to each ementioned wire rod on the conditions held for 30 seconds at 400 degrees C, wire drawing was again carried out to ter that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
15] (Example 2 of comparison) The horizontal-type continuous casting machine cast the various copper alloys of composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled he diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and the copper alloy extra fine

of the diameter of 20 micrometer was manufactured. Annealing between ** was not given the middle.
5] (Example 3 of comparison) The horizontal-type continuous casting machine cast the copper alloy of
position this invention convention outside to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled
e diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod
e diameter of 0.10mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each
mentioned wire rod on the conditions held for 30 seconds at 400 degrees C, wire drawing was again carried out to
er that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
7] Tensile strength, a defatigation fracture property, and wire drawing nature were investigated about each copper
extra fine wire obtained in examples 1 and 2 and the examples 1-3 of comparison. A defatigation fracture
erty is 2 200Ns/mm. It expressed with the number of times to the fracture when repeating bending 90 degrees,
ing out the load of the stress. One round trip was counted with 1 time. Wire drawing nature was expressed with
alue which **(ed) the amount of wire drawings by the number of times of fracture when carrying out a
nuation wire drawing to 20 micrometers from 30 micrometers. The analysis value of alloy composition is shown
ble 1, and results of an investigation are shown in Tables 2-5, respectively. A drawing condition and annealing
itions were written together in Tables 2-5.
8]
le 1]

合金	Ag	Cr	Zr	Ti		合金	Ag	Cr	Zr	Ti
1	1.0	--	--	--	本発明規定外組成合金	10	0.2	--	--	--
2	2.0	--	--	--		11	--	0.15	--	--
3	4.0	--	--	--		12	--	--	0.05	--
4	--	0.3	--	--		13	--	0.04	0.03	--
5	--	1.3	--	--		14	--	--	--	0.1
6	--	--	0.25	-						
7	--	0.28	0.22	--						
8	--	--	--	0.5						
9	--	--	--	3.8						

(注) 単位wt%.

19]
ble 2]

試料	合金	焼鈍サイズ # mm	焼鈍温度 ℃	引張強さ N／㎟	疲労破断 回数×10⁶	伸線性 kg／1断線
1	1	0．1	400	840	17	3．9
2		0．05	400	800	10	4．1
3	2	0．1	550	880	23	3．5
4		0．1	400	950	40	3．8
5		0．1	300	970	42	3．6
6		0．05	400	900	35	4．2
7	3	0．1	400	1010	45	3．6
8		0．05	400	960	41	3．4
9	4	0．1	400	890	24	3．5
10		0．05	400	850	18	4．0
11	5	0．1	400	960	41	3．5
12		0．05	400	920	37	3．7

e) Diameter of diameter-(96%) ->of diameter-(99.99%)--> of #10mm 0.1mm 0.02mm Diameter of diameter [of ıeter / of 10mm /-(99.9975%) ->0.05mm]-(84%) ->0.02mm Sample No.1-12 are an example 1.

0]

le 3]

試料	合金	焼鈍線径 # mm	焼鈍温度 ℃	引張強さ N／㎟	疲労破断 回数×10⁶	伸線性 kg／1断線
13	6	0．1	400	850	15	3．8
14		0．05	400	800	10	4．1
15	7	0．1	400	940	35	3．5
16		0．05	400	900	28	3．8
17	8	0．1	400	1100	50	3．1
18		0．05	400	1050	44	3．3
19	9	0．1	400	1210	57	3．0
20		0．05	400	1140	53	3．1
21	2	0．1	570	840	14	3．7
22		0．1	280	990	43	3．4
23	3	0．1	570	910	29	3．6
24		0．1	280	1060	45	3．3

ıte) Diameter of #10mm -- (99.99%) Diameter of -> 0.1mm (96%) Diameter of ->0.02mm Diameter of diameter [of

:n]-(99.9975%) ->0.05mm (84%) Diameter of ->0.02mm Sample No.13-20 are an example 1 and sample No.21-
'e an example 2.
1]
le 4]

試料	合金	焼鈍線径 # mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断回数×10⁶	伸線性 kg／1断線
25	2	0．3	400	980	33	1．3
26		0．03	400	720	2．1	2．8
27	3	0．3	400	1010	38	1．5
28		0．03	400	760	3．3	2．6
29	4	0．3	400	910	18	1．1
30		0．03	400	680	1．1	2．2
31	6	0．3	400	870	15	0．8
32		0．03	400	620	0．9	1．4
33	7	0．3	400	960	28	0．7
34		0．03	400	730	1．8	1．6
35	8	0．3	400	1070	39	1．9
36		0．03	400	790	3．8	2．7

e) Diameter of diameter-(99.56%) ->of diameter-(99.91%)--> of #10mm 0.3mm 0.02mm Diameter of diameter
diameter / of 10mm /-(99.9991%) ->0.03mm]-(55.56%) ->0.02mm. [0022]
le 5]

分類	試料	合金	焼鈍サイズ # mm 径	焼鈍温度 ℃	引張強さ N/mm²	疲労破断回数×10⁶	伸線性 kg/1断線
比較例2	37	2	中間焼鈍なし		1050	34	0.34
	38	3	〃		1060	36	0.41
	39	4	〃		820	16	0.22
	40	6	〃		820	14	0.32
	41	7	〃		840	18	0.50
	42	8	〃		1010	33	0 37
比較例3	43	10	0.1	400	920	19	0.33
	44		0.05	400	870	14	0.52
	45	11	0.1	400	650	1.0	2.83
	46		0.05	400	620	0.8	2.52
	47	12	0.1	400	720	3.5	1.4
	48		0.05	400	620	1.1	1.6
	49	13	0.1	400	810	9.5	1.7
	50		0.05	400	780	3.3	1.2
	51	14	0.1	400	950	18	0.52
	52		0.05	400	920	21	0.44

(Note) Diameter of #10mm -(99.9996%)-------- Diameter of ->0.02mm (with no intermediate annealing) Diameter of 10mm -- (99.99%) Diameter of -> 0.1mm (96%) Diameter of ->0.02mm Diameter of diameter [of 10mm]-(99.9975%) ->0.05mm (84%) Diameter of ->0.02mm. [0023] In having wire drawing nature 3.0kg [per one open circuit] or more, each sample No.1-24 of the example of this invention is excellent also in intensity and the defatigation-proof property, so that more clearly than Tables 2-5 (two or more [800Ns //mm] tensile strength and th number of times of defatigation fracture more than 107 times). On the other hand, example 1 of comparison No.25-3 and example 2 of comparison Since the rate of cold working separated from the convention of this invention, No.37- are the example 3 of comparison. Since No.43-52 had few amounts of alloy elements, they were that to which wire drawing nature falls and neither is suitable for practical use. Moreover, thing to which the rate of cold working after last intermediate annealing exceeded 99% (No.25, 27, 29, 31, 33, 35) The waist is weakly inferior to coiling nature (i does not display), and the aforementioned rate of cold working is less than 80% of thing (No.26, 28, 30, 32, 34, 36). was inferior to tensile strength and the defatigation fracture property. No.45-50 were inferior in at least one sort of tensile strength and a defatigation fracture property among those for which the amount of alloy elements was insufficient.

[0024]

[Effect of the Invention] As stated above, moreover, by this invention, since the crystallization object contained ther distributes a transposition cell minutely and uniformly, the copper alloy used by this invention is excellent in cold-working nature, and it is predetermined conditions about the aforementioned copper alloy, and since it cold-works putting in annealing if needed, it can manufacture an extra fine wire 50 micrometers or less good. The extra fine wir furthermore obtained in this invention is excellent also in intensity and a defatigation-proof property. Therefore, this invention is applied to manufacture of a coil etc. and does a remarkable effect so.

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HNICAL FIELD

technical field to which invention belongs] this invention is excellent in wire drawing nature, intensity, a fatigue-f property, etc., and relates to the manufacture method of the copper alloy extra fine wire of 50 micrometers or less ire sizes suitable for especially the coil.

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[OR ART

:scription of the Prior Art] Wire drawing nature, intensity, a fatigue-proof property, etc. are required of the copper ıy extra fine wire used for a coil etc. Since especially wire drawing nature influences cost greatly, it is important. : tough pitch copper, the copper alloy containing Sn, the copper alloy containing 0.2% or less of Ag, etc. have been ıventionally used for such a copper alloy extra fine wire. And with the miniaturization of a pocket device in recent .rs, 20 micrometers is asked for thinning from 50 micrometers or less and 30 more micrometers at the extra fine wire coils, and greater importance is increasingly attached to intensity, a fatigue-proof property, etc. than to before.

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ECT OF THE INVENTION

:ct of the Invention] As stated above, moreover, by this invention, since the crystallization object contained there butes a transposition cell minutely and uniformly, the copper alloy used by this invention is excellent in cold-:ing nature, and it is predetermined conditions about the aforementioned copper alloy, and since it cold-works ng in annealing if needed, it can manufacture an extra fine wire 50 micrometers or less good. The extra fine wire ermore obtained in this invention is excellent also in intensity and a defatigation-proof property. Therefore, this ıtion is applied to manufacture of a coil etc. and does a remarkable effect so.

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HNICAL PROBLEM

blem(s) to be Solved by the Invention] However, if the conventional copper alloy extra fine wire became a ıeter 50 micrometers or less, it will become easy to disconnect it, and the problem has produced it for productivity. ı, by selecting processing conditions, this invention person etc. searched for various copper alloys which are llent in cold-working nature, and it finds out that thinning can be carried out to a diameter 20 micrometers or less, a copper alloy, a Cu-Cr alloy, etc. which contain Ag 1% or more advance research further, and came to complete invention. The purpose of this invention is for the wire size which is excellent in wire drawing nature, intensity, a ue-proof property, etc. to offer the manufacture method of a copper alloy extra fine wire 50 micrometers or less.

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ANS

ɜans for Solving the Problem] Invention according to claim 1 cold-v orks the copper alloy elasticity material taining unusual appearances, such as a crystallization object. When it is the manufacture method of the copper alloy a fine wire of 50 micrometers or less of wire sizes which gives intermediate annealing if needed, the rate of cold king from the aforementioned copper alloy elasticity material is made into 99.999% or less and it gives rmediate annealing It is the manufacture method of the copper alloy extra fine wire which makes the rate of cold king between intermediate annealing 99.999% or less, and is characterized by making the rate of cold working after last intermediate annealing 80 - 99%.

)5] Invention according to claim 2 is the manufacture method of the copper alloy extra fine wire according to claim ıaracterized by the copper alloy elasticity material containing unusual appearances, such as a crystallization object, ıg a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr alloy, a Cu-0.2-1.5wt%Cr-0.1-0.3wt% ılloy, or a Cu-0.3-4.0wt%Ti alloy.

)6] Invention according to claim 3 is the manufacture method of the copper alloy extra fine wire according to claim 2 characterized by holding intermediate annealing for [1 second -] 30 minutes, and giving it at 300-550 degrees

)7]

ıbodiments of the Invention] this invention is the method of cold-working the copper alloy elasticity material taining unusual appearances, such as a crystallization object, by predetermined working ratio, giving intermediate ealing if needed, and processing it into the extra fine wire of 50 micrometers or less of wire sizes. A sludge etc. is tained in unusual appearances, such as the aforementioned crystallization object. As a copper alloy elasticity erial, minor diameter ingots, such as a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr y, a Cu-0.2-1.5wt%Cr-0.1-0.3wt%Zr alloy, or a Cu-0.3-4.0wt%Ti alloy, hot rolling material (rough drawing wire), extrusion material, an annealed material, etc. are mentioned. The aforementioned copper alloy elasticity material is ɔessed between the colds by rolling, grooved-roll rolling, drawing-out processing, wire drawing, etc., and is ɔessed into the extra fine wire of a request configuration.

)8] Cold working is distributing minutely in the shape of a staple fiber, respectively, and as for these distribution ɛct, in each aforementioned copper alloy, unusual appearances (Ag particle, Cr particle, a Zr-Cu compound particle, Cu compound particle, etc.), such as a crystallization object of an alloy element, achieve the operation which ributes minutely and uniformly the dislocation cell formed in a copper alloy matrix in connection with cold king, and raise the cold-working nature of each aforementioned copper alloy to it. Since there are few ementioned crystallization objects etc. under at a minimum, when no reasons for a convention of the amount of y elements of each aforementioned copper alloy are distributed minutely [a dislocation cell] and uniformly but eed an upper limit, a crystallization object etc. is for turning and causing an open circuit big and rough remarkably.

)9] the aforementioned crystallization object is detailed in a dislocation cell as mentioned above -- and although it alizes, on the other hand, if cold working progresses, a dislocation cell will turn minutely remarkably, pinning of dislocation is carried out there, and an open circuit becomes easy to occur

10] Then, in this invention, when the rate of cold working from the aforementioned copper alloy elasticity material eeds 99.999%, intermediate annealing is given and an open circuit is prevented. By intermediate annealing, ocation moves in heat activity, a dislocation cell turns big and rough, and cold-working nature is improved. The rate old working between intermediate annealing in the case of giving intermediate annealing two or more times is made 999% or less like the rate of cold working from the aforementioned copper alloy elasticity material. However, the of cold working after the last intermediate annealing is specified to 80 - 99%. When the intensity which needs the ɜon for a copper alloy extra fine wire at less than 80% is not obtained but it exceeds 99%, a dislocation cell is for ıing and becoming easy to disconnect in the cases, such as coiling, minutely. In addition, a Cu-Cr alloy, a Cu-Zr

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ᐱMPLE

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ample] An example explains this invention in detail below.
ample 1) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this :ntion convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of ım, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of)mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod he conditions held for 30 seconds at 300-550 degrees C, wire drawing was again carried out to it after that, and the per alloy extra fine wire of the diameter of 20 micrometer (0.02mm) was manufactured.
13] (Example 2) The horizontal-type continuous casting machine cast the various copper alloys of the composition ıis invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of ım, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of)mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod he conditions held for 30 seconds at 580 degrees C or 280 degrees C, wire drawing was again carried out to it after ;, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
14] (Example 1 of comparison) The horizontal-type continuous casting machine cast the various copper alloys of composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled he diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod he diameter of 0.30mm, or the diameter of 0.03mm. Subsequently, annealing between ** was given to each ementioned wire rod on the conditions held for 30 seconds at 400 degrees C, wire drawing was again carried out to ter that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
15] (Example 2 of comparison) The horizontal-type continuous casting machine cast the various copper alloys of composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled he diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and the copper alloy extra fine e of the diameter of 20 micrometer was manufactured. Annealing between ** was not given the middle.
16] (Example 3 of comparison) The horizontal-type continuous casting machine cast the copper alloy of nposition this invention convention outside to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled he diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod he diameter of 0.10mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each rementioned wire rod on the conditions held for 30 seconds at 400 degrees C, wire drawing was again carried out to fter that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
17] Tensile strength, a fatigue fracture property, and wire drawing nature were investigated about each copper alloy ra fine wire obtained in examples 1 and 2 and the examples 1-3 of comparison. A fatigue fracture property is 2)Ns/mm. It expressed with the number of times to the fracture when repeating bending 90 degrees, carrying out the d of the stress. One round trip was counted with 1 time. Wire drawing nature was expressed with the value which ** .) the amount of wire drawings by the number of times of fracture when carrying out a continuation wire drawing to micrometers from 30 micrometers. The analysis value of alloy composition is shown in Table 1, and results of an estigation are shown in Tables 2-5, respectively. A drawing condition and annealing conditions were written ;ether in Tables 2-5.
)18]
ıble 1]

合金	Ag	Cr	Zr	Ti		合金	Ag	Cr	Zr	Ti
1	1.0	--	--	--	本発明規定外組成合金	10	0.2	--	--	--
2	2.0	--	--	--		11	--	0.15	--	--
3	4.0	--	--	--		12	--	--	0.05	--
4	--	0.3	--	--		13	--	0.04	0.03	--
5	--	1.3	--	--		14	--	--	--	0.1
6	--	--	0.25	-						
7	--	0.28	0.22	--						
8	--	--	--	0.5						
9	--	--	--	3.8						

(注) 単位wt%。

9]
le 2]

試料	合金	焼鈍サイズ # mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断 回数×10⁶	伸線性 kg／1断線
1 2	1	0.1 0.05	400 400	840 800	17 10	3.9 4.1
3 4 5 6	2	0.1 0.1 0.1 0.05	550 400 300 400	880 950 970 900	23 40 42 35	3.5 3.8 3.6 4.2
7 8	3	0.1 0.05	400 400	1010 960	45 41	3.6 3.4
9 10	4	0.1 0.05	400 400	890 850	24 18	3.5 4.0
11 12	5	0.1 0.05	400 400	960 920	41 37	3.5 3.7

ɔte) Diameter of diameter-(96%) ->of diameter-(99.99%)--> of #10mm 0.1mm 0.02mm Diameter of diameter [of :meter / of 10mm /-(99.9975%) ->0.05mm]-(84%) ->0.02mm Sample No.1-12 are an example 1.

20]
.ble 3]

試料	合金	焼鈍線径 # mm	焼鈍温度 ℃	引張強さ N／㎟	疲労破断 回数×10^6	伸線性 kg／1断線
13	6	0．1	400	850	15	3．8
14		0．05	400	800	10	4．1
15	7	0．1	400	940	35	3．5
16		0．05	400	900	28	3．8
17	8	0．1	400	1100	50	3．1
18		0．05	400	1050	44	3．3
19	9	0．1	400	1210	57	3．0
20		0．05	400	1140	53	3．1
21	2	0．1	570	840	14	3．7
22		0．1	280	990	43	3．4
23	3	0．1	570	910	29	3．6
24		0．1	280	1060	45	3．3

ıte) Diameter of #10mm -- (99.99%) Diameter of -> 0.1mm (96%) Diameter of ->0.02mm Diameter of diameter [of ım]-(99.9975%) ->0.05mm (84%) Diameter of ->0.02mm Sample No.13-20 are an example 1 and sample No.21- ıre an example 2.

21]

ble 4]

試料	合金	焼鈍線径 # mm	焼鈍温度 ℃	引張強さ N／㎟	疲労破断 回数×10^6	伸線性 kg／1断線
25	2	0．3	400	980	33	1．3
26		0．03	400	720	2．1	2．8
27	3	0．3	400	1010	38	1．5
28		0．03	400	760	3．3	2．6
29	4	0．3	400	910	18	1．1
30		0．03	400	680	1．1	2．2
31	6	0．3	400	870	15	0．8
32		0．03	400	620	0．9	1．4
33	7	0．3	400	960	28	0．7
34		0．03	400	730	1．8	1．6
35	8	0．3	400	1070	39	1．9
36		0．03	400	790	3．8	2．7

(Note) Diameter of diameter-(99.56%) ->of diameter-(99.91%)--> of #10mm 0.3mm 0.02mm Diameter of diametei [of diameter / of 10mm /-(99.9991%) ->0.03mm]-(55.56%) ->0.02mm. [0022]

[Table 5]

分類	試料	合金	焼鈍サイズ # mm 径	焼鈍温度 ℃	引張強さ N／mm²	疲労破断回数×10⁶	伸線性 kg／1断線
比較例2	37	2	中間焼鈍なし		1050	34	0.34
	38	3	〃		1060	36	0.41
	39	4	〃		820	16	0.22
	40	6	〃		820	14	0.32
	41	7	〃		840	18	0.50
	42	8	〃		1010	33	0 37
比較例3	43	10	0.1	400	920	19	0.33
	44		0.05	400	870	14	0.52
	45	11	0.1	400	650	1.0	2.83
	46		0.05	400	620	0.8	2.52
	47	12	0.1	400	720	3.5	1.4
	48		0.05	400	620	1.1	1.6
	49	13	0.1	400	810	9.5	1.7
	50		0.05	400	780	3.3	1.2
	51	14	0.1	400	950	18	0.52
	52		0.05	400	920	21	0.44

(Note) Diameter of #10mm -(99.9996%)-------- Diameter of ->0.02mm (with no intermediate annealing) Diameter of 10mm -- (99.99%) Diameter of -> 0.1mm (96%) Diameter of ->0.02mm Diameter of diameter [of 10mm]-(99.9975%) ->0.05mm (84%) Diameter of ->0.02mm. [0023] In having wire drawing nature 3.0kg [per on open circuit] or more, each sample No.1-24 of the example of this invention is excellent also in intensity and the fatigue-proof property, so that more clearly than Tables 2-5 (two or more [800Ns //mm] tensile strength and the number of times of fatigue fracture more than 107 times). On the other hand, example 1 of comparison No.25-36 an example 2 of comparison Since the rate of cold working separated from the convention of this invention, No.37-42 , the example 3 of comparison. Since No.43-52 had few amounts of alloy elements, they were that to which wire drawing nature falls and neither is suitable for practical use. Moreover, thing to which the rate of cold working aftei last intermediate annealing exceeded 99% (No.25, 27, 29, 31, 33, 35) The waist is weakly inferior to coiling nature does not display), and the aforementioned rate of cold working is less than 80% of thing (No.26, 28, 30, 32, 34, 36) was inferior to tensile strength and the fatigue fracture property. No.45-50 were inferior in at least one sort of tensil strength and a fatigue fracture property among those for which the amount of alloy elements was insufficient.

[Translation done.]